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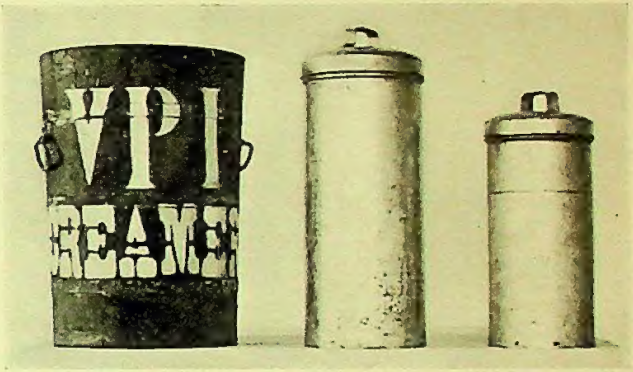

ICE CREAM MAKING IS A VERY IMPORTANT PART OF THE CREAMERY BUSINESS IN VIRGINIA, AND CAN BE MADE A SOURCE OF PROFIT TO THE CREAMERY IN ALMOST ANY LOCALITY.

Effects of Binders Upon the Melting and Hardness of Ice Cream

BY

C. W. HOLDAWAY and R. R. REYNOLDS

BLACKSBURG, MONTGOMERY COUNTY, VIRGINIA

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EFFECTS OF BINDERS UPON THE MELTING AND HARDNESS OF ICE CREAM

By C. W. Holdaway and R. R. Reynolds

The manufacture of ice cream has become an important part of the business of the commercial creamery. The product is sold in bulk, in brick, and in fancy shapes. Brick cream and fancy cream are not consumed for some little time after they are served on the table and they are therefore, unduly exposed to the danger of softening and melting. In order to overcome this, ice cream makers have been in the habit of using various materials for preventing this undesirable tendency. The materials generally employed for this purpose are called binders and fillers, and consist of gelatin, gum tragacanth, corn starch, eggs, etc. They may be used either singly or in combination.

In a bulletin previously issued by this Station the subject of smoothness and stability of texture of ice cream was discussed. It was shown that the amount of fat in cream best adapted for ice cream making varies from eighteen to twenty per cent; also that the best materials to use as fillers and binders are those that become jelly-like when mixed with water, such as gelatin, gums and cooked starches. By adding these substances a smoother ice cream was made and it retained its smooth texture for a longer time. Homogenized cream made ice cream that was much smoother and more stable in texture than unhomogenized cream.

The experiments reported in this paper were designed to ascertain the relative value of some of the common binders and fillers from the standpoint of hardness and heat resistance of the ice cream, also the additional effect of varying per cents of fat when used with the same.

Plan of Work

Two methods of measuring the stability of the brick ice cream were used. First, determination of the hardness of the cream when ready to ship, and second, determination of the time taken for the different creams to melt under standardized summer conditions.

Preparation of the Ice Cream

The per cent of butter fat in the brick ice cream found on the market varies considerably owing to the fact that ordinary stock cream containing a low per cent of fat is used extensively while the better grades of

cream may contain a much higher per cent of fat. For this reason brick cream was made from eight per cent cream, nineteen per cent cream, and thirty per cent cream to determine the value of the fat content with relation to the filler. The most common ingredients used as fillers and binders are gelatin, gum tragacanth and corn starch. It will be noted in the formulas that there were three grades of cream used.

The cream was frozen in a gallon hand freezer and made into brick 3 x 4½ x 4 inches.

The brick were packed in salt and ice, and allowed to harden for twelve to fourteen hours. All the brick containing a given per cent of fat were made from the same cream and packed in the same ice and salt. In this way only the filler varied. At the end of the hardening period the value of each filler was determined.

Formulas for Making the Ice Cream Used in These Experiments

Series eight per cent fat	Series nineteen per cent fat	Series thirty per cent fat
No. 1—Control	No. 6—Control	No. 11—Control
1 gallon cream 8% fat.	1 gallon cream 19% fat.	1 gallon cream 30% fat.
53 cc. vanilla.	53 cc. vanilla.	53 cc. vanilla.
10.5 ozs. sugar.	10.5 ozs. sugar.	10.5 ozs. sugar.
No. 2—Gelatin	No. 7—Gelatin	No. 12—Gelatin
1 gallon cream 8% fat.	1 gallon cream 19% fat.	1 gallon cream 30% fat.
53 cc. vanilla.	53 cc. vanilla.	53 cc. vanilla.
10.5 ozs. sugar.	10.5 ozs. sugar.	10.5 ozs. sugar.
0.4 oz. gelatin.	0.4 oz. gelatin.	0.4 oz. gelatin.
No. 3—Gelatin	No. 8—Gelatin	No. 13—Gelatin
1 gallon cream 8% fat.	1 gallon cream 19% fat.	1 gallon cream 30% fat.
53 cc. vanilla.	53 cc. vanilla.	53 cc. vanilla.
10.5 ozs. sugar.	10.5 ozs. sugar.	10.5 ozs. sugar.
1.0 oz. gelatin.	1.0 oz. gelatin.	1.0 oz. gelatin.
No. 4—Gum Tragacanth	No. 9—Gum Tragacanth	No. 14—Gum Tragacanth
1 gallon cream 8% fat.	1 gallon cream 19% fat.	1 gallon cream 30% fat.
53 cc. vanilla.	53 cc. vanilla.	53 cc. vanilla.
10.5 ozs. sugar.	10.5 ozs. sugar.	10.5 ozs. sugar.
0.4 oz. gum tragacanth.	0.4 oz. gum tragacanth.	0.4 oz. gum tragacanth.
No. 5—Starch	No. 10—Starch	No. 15—Starch
1 gallon cream 8% fat.	1 gallon cream 19% fat.	1 gallon cream 30% fat.
53 cc. vanilla.	53 cc. vanilla.	53 cc. vanilla.
10.5 ozs. sugar.	10.5 ozs. sugar.	10.5 ozs. sugar.
0.4 oz. cooked starch.	0.4 oz. cooked starch.	0.4 oz. cooked starch.

References in the text to the amount of filler are based on the ten-gallon unit, owing to the fact that ice cream makers use this unit as a standard.

Determination of the Hardness of the Ice Cream

Apparatus used: The apparatus used for determining hardness was made from the description of a similar piece of apparatus by A. E. Perkins.[1] Fig. 1 is a photograph of the apparatus used in these experiments. It consisted of a wooden frame made of 2x4-inch lumber, with cross pieces on the bottom so that it stood firmly in an upright position. A cross piece, about one foot from the bottom of the frame, made the support for holding the sample. At the top of this support was an adjustable

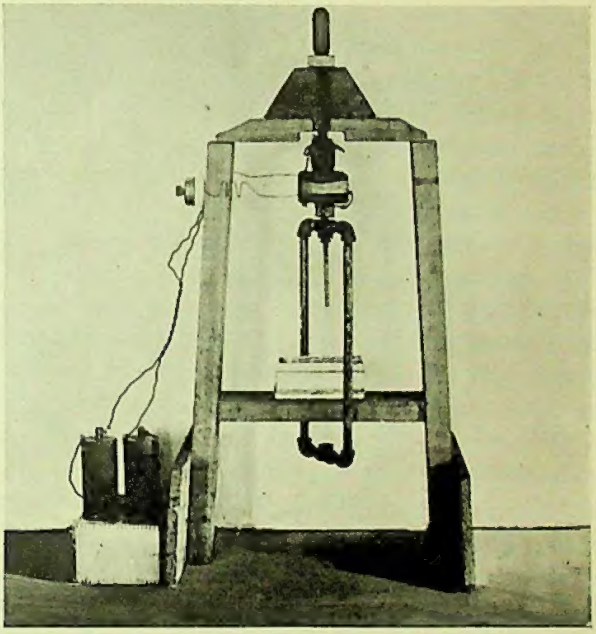

FIG. 1—THE APPARATUS FOR DETERMINING HARDNESS

wooden screw for holding the electro-magnet. By adjustment with this screw the magnet could be lowered or raised several inches. This adjustment was necessary so that the height of the needle could be made constant with all samples. The platform could have been made adjustable and the magnet rigid, had that been more desirable. The drop frame which holds the needle and which is held up by the magnet until the current from the batteries is broken, was made from very light three-eighths-inch piping, the width being sufficient to give a free drop without touching the mould, and long enough to reach below the platform when the magnet was at its highest

[1] Journal of Industrial and Engineering Chem., Vol. 6, No. 2, p. 136. 1914.

point. The wires from the magnet led to a cut-off key on the side frame and from there to a pair of dry cells from which current was derived. The needles were of different sizes but the same weight, thus eliminating the necessity of making adjustments to get constant weight. The needles were marked from their points upward, in centimeters and fractions thereof, to show the depth of penetration. The height of the drop was always 100 mm., being measured carefully with a metric rule before each determination.

Determination of Hardness

In making the determination, the frame with a suitable needle and weights is suspended from the electro-magnet, and the material to be tested placed in position beneath the needle, the height being regulated as described above. The frame is then released by means of the key. The depth of penetration is ascertained from the marks on the needles and confirmed by measuring with the metric rule.

The suspension of the weights far below the needle brings the center of gravity of the falling portion of the apparatus below the point of the needle, causing the latter to invariably assume a vertical position, making it much easier to ascertain the true depth of penetration than would be the case if the point of the needle were at or below the center of gravity. After its release by the electro-magnet, the apparatus meets with no resistance in its fall, except that offered by the air, until the point of the needle reaches the surface of the cream.

It might be argued that gravity acts through a greater distance in the case of a sample which is penetrated 30 mm. than in case of one which is penetrated, say only 15 mm.; or again, it might be argued that the amount of friction on the sides of a small needle would be proportionately greater than that on a larger needle, on account of the greater area in proportion to its volume. These objections, if they are applicable, would tend to counteract each other.

The amount of weight acting on the needle is known, and the distance through which it falls is constant. If, however, too much weight or too small a needle is employed the needle continues to sink slowly, making an accurate reading of the depth of penetration impossible. In the reverse case with too large a needle or too little weight, the penetration is of course much less and the per cent of experimental error proportionately greater. As there was a large variation in the hardness of the various fillers three sets of needles were employed, and in this way much of the error was eliminated. The size of the needles were large, 5/16-inch or 7.93 mm., medium 4/16-inch or 6.35 mm., and small 3/16-inch or 4.76 mm.

The tests were made by allowing each needle to penetrate the cream three times. The point of penetration was varied from center to points near the edge as there was a possibility of the cream being harder near the edge than in the center. In the table will be found the depth of penetration of each needle expressed in mm. This work was done in a cold storage with the temperature near 0° C., after which the time taken for the different creams to melt under standardized summer conditions was noted.

Determination of the Time Required for the Different Creams to Melt under Standarized Summer Conditions

After determining the hardness of the cream the brick were removed to a room having a standard temperature of 25° C. Each brick was taken out of its mould and placed on a block of wood the exact size of the brick of cream. Through the block of wood a nail was driven upward, penetrating the center of the brick, which prevented the cream from slipping when it melted around the bottom. Each brick was brought to a standard weight of five hundred grams. In this way the weights taken every hour for four consecutive hours show the value of the filler when compared with the control cream which contains no filler. Duplicate samples were used for each trial. Three trials were made, making six brick tried for each per cent of cream with the various fillers. The cream which offered the greatest resistance to the penetration of the needles was the hardest, while that which retained the greatest weight after any standard melting time, had the highest melting resistance.

TABLE I—*Experiments with eight per cent Cream*

SHOWING THE DEPTH OF PENETRATION OF NEEDLE IN THE HARDNESS TEST AND LOSS IN WEIGHT BY MELTING OF THE ICE CREAM BRICK

FILLER	SIZE NEEDLE IN MM.	PENETRATION IN MM.	WEIGHT OF EACH BRICK IN GRAMS AFTER MELTING FOR			
			1 Hour	2 Hours	3 Hours	4 Hours
Control	7.93	25.40 23.805	454	315	193	119
	6.35	44.45 44.45	450	297	179	104
	4.76	69.85 68.25				
4 Ounces Gelatin Per Ten Gallons	7.93	7.93 6.35	480	385	276	162
	6.35	9.54 9.425	485	385	281	150
	4.76	19.05 19.05				
10 Ounces Gelatin Per Ten Gallons	7.93	3.18 3.18	500	482	348	250
	6.35	9.54 9.54	500	492	329	246
	4.76	12.70 11.10				
4 Ounces Gum Tragacanth Per Ten Gallons	7.93	20.631 20.631	480	343	211	107
	6.35	31.75 31.75	482	346	218	118
	4.76	50.80 50.80				
4 Ounces Corn Starch Per Ten Gallons	7.93	7.93 7.93	468	361	260	184
	6.35	14.29 14.29	466	364	268	195
	4.76	28.58 28.58				

EXPERIMENTS WITH ICE CREAM CONTAINING EIGHT PER CENT FAT

An inspection of Table I shows that the hardness of the different kinds of eight per cent cream was found to be in the following order, the hardest being mentioned first.

Cream containing 10 ounces gelatin.
" " 4 " "
" " 4 " corn starch.
" " 4 " gum tragacanth.
Control.

The melting resistance follows the same order.

In the control, the ice crystals were very long and coarse, with little power to resist pressure and heat. The control lost weight the fastest. A foamy coating was noticed on the outside of the brick while the center was a cake of ice with vertical holes, through which the water penetrated to the bottom. Many of the openings were due to the penetration of the needles.

When four ounces of gelatin were added the cream assumed a glossy appearance, this being noticeable in all the creams containing a similar amount of gelatin. At first, only slight melting around the bottom and a glistening watery look along the sides was noticeable. After standing an hour, very small pieces began to break away in an irregular manner. The breaking increased rapidly until the brick became more oval in shape, and then the cream slipped off as a viscous mass. The mode of sloughing was similar in all cases where four ounces of gelatin were used.

Ten ounces of gelatin increased the hardness. At the end of the first hour cracks were noticed in the top of each brick, and these increased until a large piece would break away. The top spread out and hung over the support. This cream had a duller appearance than the cream containing the four ounces of gelatin.

The addition of gum tragacanth did not materially increase the hardness of ice cream. The gum cream melted very little slower than the control. The melting proceeded very rapidly during the second hour, the melted portion being very viscous. It melted evenly and left a smooth surface. The extended portion ran off rapidly, leaving the characteristic shape seen in the nineteen per cent cream, see Fig. 5.

Corn starch produced a cream with about the same hardness as the cream containing four ounces of gelatin. Melting took place at first around the base and sides. The top of the brick spread out slightly and hung over the sides, and this portion sloughed away rapidly. The outside had a fluffy, dry, rough appearance.

TABLE II—*Experiments with nineteen per cent Cream*

SHOWING THE DEPTH OF PENETRATION OF NEEDLE IN THE HARDNESS TEST AND LOSS IN WEIGHT BY MELTING OF THE ICE CREAM BRICK

FILLER	SIZE NEEDLE IN MM.	PENETRATION IN MM.	WEIGHT OF EACH BRICK IN GRAMS AFTER MELTING FOR			
			1 Hour	2 Hours	3 Hours	4 Hours
Control	7.93	25.40 25.40	473	359	226	123
	6.35	50.80 48.60	475	357	235	122
	4.76	64.00 63.50				
4 Ounces Gelatin Per Ten Gallons	7.93	3.173 3.173	500	431	302	256
	6.35	6.35 6.35	500	447	354	253
	4.76	15.525 15.525				
10 Ounces Gelatin Per Ten Gallons	7.93	1.587 1.587	500	500	498	498
	6.35	4.761 4.761	500	500	499	499
	4.76	6.35 6.35				
4 Ounces Gum Tragacanth Per Ten Gallons	7.93	19.05 19.05	455	292	151	50
	6.35	38.1 38.1	448	272	133	46
	4.76	63.5 63.5				
4 Ounces Corn Starch Per Ten Gallons	7.93	6.35 6.35	485	424	293	223
	6.35	9.525 9.525	486	382	243	190
	4.76	12.70 12.70				

EXPERIMENTS WITH NINETEEN PER CENT CREAM

Table No. 2 shows that the hardness of the different kinds of nineteen per cent cream is in the following order from hard to soft.

Cream containing 10 ounces gelatin.
" " 4 " "
" " 4 " corn starch.
" " 4 " gum tragacanth.
Control.

The melting resistance was found to be in the following order from high to low.

Cream containing 10 ounces gelatin.
" " 4 " "
" " 4 " corn starch.
Control.
" containing 4 " gum tragacanth.

The first three follow the same order for hardness and melting resistance. The control was the softest as shown by the penetration of the two largest needles, while the cream containing gum melted faster than the control cream.

FIG 2—CONTROL NINETEEN PER CENT CREAM AFTER MELTING THREE HOURS

When fillers are used with the ice cream the amount of fat that gives best results from the standpoint of hardness is nineteen per cent. The two controls, eight per cent and nineteen per cent, show very near the same hardness.

Figure 2 shows nineteen per cent cream after melting for three hours. This illustrates the whipped appearance observed in all the control creams.

When four ounces of gelatin were added to nineteen per cent cream no loss of weight was noticeable the first hour. A slight melting soon took place around the bottom, the top extended slightly beyond the sides and

FIG. 3—Ice Cream Containing Four Ounces Gelatin Per Ten Gallons After Melting Three Hours

readily sloughed away after about two hours. After three hours cracks appeared in the top, and as these increased in number the size of the pieces that broke away increased.

Figure 3 shows cream made with four ounces of gelatin after three hours melting. The manner of melting is characteristic for the various per cents containing four ounces of gelatin.

FIG. 4—Ice Cream Containing Ten Ounces Gelatin Per Ten Gallons After Melting Three Hours

Cream containing a large per cent of gelatin has a dull appearance when compared with smaller amounts. In the brick containing ten ounces of gelatin there was a slight drooping of the corners after two hours, the water oozing out along the sides and around the bottom. Small holes appeared after three hours, but little change in the shape of the brick was noticeable. The weights which were taken each hour showed a small loss. Figure 4 illustrates the form of the brick after melting three hours.

Nineteen per cent cream containing four ounces of gum showed little change in appearance after the first hour, and there was no loss of weight. During the second hour the size of the brick decreased with noticeable sinking of the corners. The melted fluid appeared as if the water had slightly separated from the other constituents (as in fresh butter milk) giving the surface a rather glossy appearance when closely examined. From a distance the surface was very smooth and regular. Figure 5 shows nineteen per cent cream, containing gum, after three hours of melting.

FIG. 5—Ice Cream Containing Four Ounces Gum Tragacanth Per Ten Gallons After Melting Three Hours

The nature of the melting of cream containing gum tragacanth shows that this material does not bind at all, but on the contrary increases the softening qualities. It increases the viscosity, smoothness and color of the cream.

Nineteen per cent cream containing corn starch melted only slightly the first hour. The surface became very dry as if the moisture had entered the inner part of the brick. The melted portion slipped away evenly from top to bottom in layers, showing that corn starch does not form a jelly, like gelatin, but acts as a filler only.

TABLE III—*Experiments with thirty per cent Cream*

SHOWING THE DEPTH OF PENETRATION OF NEEDLE IN THE HARDNESS TEST AND LOSS IN WEIGHT BY MELTING OF THE ICE CREAM BRICK

FILLER	SIZE NEEDLE IN MM.	PENETRATION IN MM.	WEIGHT OF EACH BRICK IN GRAMS AFTER MELTING FOR			
			1 Hour	2 Hours	3 Hours	4 Hours
Control	7.93	50.80 50.80	489	368	194	136
	6.35	63.50 63.5	488	396	224	127
	4.76	76.2 76.2				
4 Ounces Gelatin Per Ten Gallons	7.93	19.05 19.05	500	500	344	236
	6.35	31.75 31.75	485	484	321	212
	4.76	44.45 44.45				
10 Ounces Gelatin Per Ten Gallons	7.93	12.7 12.70	500	500	497	237
	6.35	19.05 19.05	500	500	496	207
	4.76	28.575 28.575				
4 Ounces Gum Tragacanth Per Ten Gallons	7.93	*76.2 76.2	343	169	46	38
	6.35	76.2 76.2	345	171	34	25
	4.76	76.2 76.2				
4 Ounces Corn Starch Per Ten Gallons	7.93	19.05 19.05	498	367	224	134
	6.35	25.4 25.4	492	344	203	144
	4.76	38.10 38.10				

*Entirely through.

In Figure 6, right hand brick, the central part has not slipped away like the corners.

FIG. 6—Ice Cream Containing Four Ounces Starch Per Ten Gallons After Melting Three Hours

EXPERIMENTS WITH THIRTY PER CENT CREAM

The results in Table No. 3 show that the various creams from hard to soft and high to low heat resistance are as follows:

Cream containing 10 ounces gelatin.
" " 4 " "
" " 4 " corn starch.
Control.
" containing 4 " gum tragacanth.

All the cream softened more quickly than in the nineteen per cent fat or eight per cent fat series. In the trial for hardness of the cream containing gum, the largest needle went entirely through the brick.

The control thirty per cent cream melted more slowly than the controls in the other series, although it was not as hard to the needle as eight per cent or nineteen per cent cream. It was much lighter than the other controls due to whipping. From these observations it may be concluded that high per cent fat makes a light, fluffy cream which is probably slightly more heat resistant than the lower per cent creams.

The thirty per cent cream containing four ounces gelatin was much softer than eight per cent and nineteen per cent creams containing similar amounts of gelatin. Melting took place very slowly, no change being noticeable the first hour.

It should be observed that all the lots of gelatin cream containing thirty per cent fat were softer to the needle than lower per cents and they melted faster than nineteen per cent cream. Compared with eight per cent cream the gelatin batches of the thirty per cent cream took longer to melt. The gum and starch batches melted quicker.

The cream containing ten ounces of gelatin had a dry appearance when compared with that containing only four ounces. During the first and second hours no loss of weight was noticeable, the cream being very dry and spongy when touched. After this cream was pressed it assumed its original shape due to its elasticity. Figure 4 shows its appearance after three hours melting. Note that ten ounces gelatin with thirty per cent cream decreases the time taken to melt when compared with the same amount in lower per cent cream.

The gum cream was very soft and melted rapidly from the beginning. The melting was even, leaving a very greasy appearance, which was probably due to the presence of a high percentage of butter fat.

The cream remaining on the block during the fourth hour was entirely liquid. However, owing to its viscosity, it did not run off. Many air bubbles, due to whipping, were noticeable in the cream and the melted liquid.

Note that the batch was softer than any previous one and also melted very much faster. Evidently gum tragacanth is more beneficial when used with the lower per cents.

SUMMARY

1. *Plain Ice Cream:* In plain ice cream (control) as the per cent of fat increased the cream became softer. A medium amount of butter fat, combined with other material than milk solids, produces a stiff cream. When too much fat is present whipping takes place, producing a cream that is soft and fluffy in appearance.

Ice cream made from eight per cent cream was no harder than from nineteen per cent cream. While thirty per cent plain cream was much softer than eight per cent or nineteen per cent cream.

In plain ice cream the presence of fat increases the power to resist melting. This resistance is most noticeable between the melting of the eight per cent and nineteen per cent cream. Thirty per cent cream shows the power to resist melting to a less degree.

2. *Cream containing gelatin:* Gelatin in a large or small quantity produces similar effects, depending upon the richness of the cream used. The power to withstand pressure and the melting resistance increases as the amount of gelatin increases when compared with the control cream with a

similar fat content. The hardest and most heat resisting cream is produced with a medium per cent of fat and a large amount of gelatin.

With gelatin, the presence of fat seems to be essential to produce hardness and melting resistance until a point is reached where whipping affects the texture. After whipping begins the incorporated air reduces the hardness and melting resistance. Ice cream containing one ounce of gelatin per gallon has more the appearance of pudding than ice cream.

Four ounces of gelatin gives about the same hardness as four ounces of corn starch but it is much better, producing a smoother cream which is more stable under ordinary conditions.

3. *Cream containing gum tragacanth:* Gum tragacanth with a low per cent of fat produces a cream that is slightly harder, with slightly more power to resist heat than plain cream. As the per cent of fat is increased with this filler, the power to resist pressure and heat decreases, falling below plain cream, showing that gum tragacanth acts as a filler and not as a binder. Its most noticeable effects on the texture of ice cream, because of the nature of the gum, is to impart a smoothness which becomes sliminess when large quantities are used.

4. *Cream containing corn starch:* When corn starch is used as a filler a slight increase in hardness and melting resistance is noticeable with nineteen per cent when compared with eight per cent ice cream. Also, it produces an ice cream that is more resistant to heat than plain cream of the same per cent fat. When used as a filler it compares favorably with a similar amount of gelatin, but the starch cream is more granular than the gelatin cream, while gum tragacanth produces a smooth, soft cream.

A FEW DIRECTIONS FOR MAKING ICE CREAM

Vanilla

One-half gallon 18% cream
0.8 pound sugar
0.4 oz. vanilla extract
0.4 oz. gelatin.

Chocolate

Add 5 ozs. of bitter chocolate or
5 ozs. of cocoa cooked to a thick paste to the vanilla mixture.

Parfait[1]

One-half gallon 30% cream
Yolks of one dozen eggs
1.4 pounds sugar
0.4 oz. vanilla extract
0.4 pound of ground nuts.

Fruit

One-half gallon 18% cream
1.0 pound sugar
0.4 oz. gelatin.
1.0 quart crushed fruit.

Mousse[1]

1 gallon 30% whipped cream
2 pounds sugar.
1 pint cranberry juice (or other fruits)
½ pint lemon juice.

Sherbet[2]

1 quart of water
1 pound of sugar
1 quart of fresh strawberries
Whites of six eggs
Juice of two lemons.

[1] Iowa Bul. 123.
[2] "Dairy Technology." Larson & White.

Preparation of the Ingredients in Ice Cream Making

Cream: The cream should be sweet and of good flavor. It should contain butter fat varying from eighteen to twenty per cent, but a minimum of twelve per cent may be used. It should be kept sweet and at as low a temperature as possible for twenty-four to forty-eight hours after skimming.

Flavoring: Use a good quality of flavoring. It is cheaper and safer in the end. Extract flavoring may be added to the cream at any time. Fruit juices should not be added till the cream is slightly frozen.

Fruit: This should always be crushed and pressed through a strainer, and then sweetened with sugar. The time to add it to the ice cream is when this has become slightly frozen.

Sugar: May be mixed directly with the cream some time before it is put in the freezer, but it must be thoroughly dissolved before freezing. It may be dissolved in a small amount of water beforehand and the solution added to the cream. Three-quarters of a pound of sugar is generally used per gallon of ice cream.

Condensed milk: This is often used to give better body to the cream. Its use is restricted by the State Pure Food Laws.

Gelatin: When used should be soaked several hours in slightly warm water. Hot water produces a bad flavor when used with gelatin. It should be stirred into the cream before putting in the freezer. One to two ounces to five gallons of cream is ample.

Gum tragacanth gives best results when it is finely ground, mixed with some sugar and added to the cream several hours before putting in the freezer. One ounce of gum is enough for twenty to thirty gallons of ice cream.

Corn starch, rice or wheat flour should be boiled to a pudding consistency before adding to the cream.

Ice cream powders are generally mixtures of these fillers and binders. They are used according to directions.

Freezing the Cream

Crush the ice finely and pack it around the bottom of the freezer can without salt. Begin adding salt to the ice when the freezer is one-third full, using one pound of coarse salt to every ten pounds of ice.

The freezer should be turned slowly at first. Fast turning while the cream is warm causes buttering and gives a grainy, rough texture to the finished product. The speed should be increased so that when freezing begins the can is revolving about one hundred times per minute, and this speed should be maintained till the end. Ice cream should not be frozen hard in the freezer. When it has frozen to the consistency of a thick syrup the machine should be stopped, the dasher taken out and the cream packed down in the freezer can or transferred to another can which has been previously packed in ice and salt. Over freezing beats down the cream so that it loses much of its whipped, smooth and fluffy texture, and the volume of cream secured decreases as well.